ABSTRACT

Title of Thesis:	INVESTIGATING THE EFFECT OF PARENTAL QUESTION INPUT ON CHILDREN WITH ASD
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The current study analyzed individual mechanisms of language gains following the Solomon et al. (2014) randomized control trial (RCT) of the Play and Language for Autistic Youngsters (PLAY) Project, a DIR/Floortime based early intervention program for children with autism spectrum disorder. 80 parent-child play interactions from the original RCT were analyzed to assess the relationship between various forms of parental question input, as taught in PLAY parent trainings, and child language measures. While high parental question input did correlate with high child language measures, one targeted intervention component, parental Asked/Answered question input, did not increase following parent training and did not improve child language measures. We consider other mechanisms responsible for successful child language gains following PLAY intervention.

INVESTIGATING THE EFFECT OF PARENTAL QUESTION INPUT ON CHILDREN WITH ASD

by

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Chapter 1: Introduction

Questions in child-directed speech

Adult language input facilitates child language development, in that children acquire their first language through exposure to various forms of linguistic structure and vocabulary, as opposed to direct teaching. In typically-developing children, child-directed adult question input serves a functional purpose in syntax learning and vocabulary acquisition (Blewitt, Rump, Shealy, & Cook, 2009; Senechal, 1997; Walsh & Blewitt, 2006; Wasik & Bond, 2001). There are several types of adult question input that appear to foster the development of grammatical complexity in typically-developing children. First, self-answered questions, referred to in this paper as the "Asked and Answered" technique (e.g., "*Is it a cookie? Yes, it is a cookie.*"), allow parents to present questions in multiple syntactic forms and also provide answers. The repetition of key vocabulary allows for greater exposure to target language, as well as showing systematic relationships between sentence types in the grammar.

Studies have also shown that children better learn novel words during adult-led book readings when they are asked follow-up questions that restate the target vocabulary, similar to the vocabulary technique of "Asked and Answered" (Blewitt, Rump, Shealy, & Cook, 2009; Blewitt, 2006; Wasik & Bond, 2001). Frequency of parental use of fronted auxiliary forms predicts grammatical growth in typically-developing children, as shown through the children's own later auxiliary use and longer Mean Length of Utterances (MLU) (Newport, Gleitman, & Gleitman, 1977). "Asked and Answered" questions showcase verb auxiliaries presented in both the initial and final position of a sentence, especially in elliptical response to questions (e.g., "*Yes, it is.*").

Frequnecy of wh-question input, questions that begin with "wh" words, such as "what" or "where," is also associated with children's later auxiliary verb use and understanding of syntactic structure (Valian & Casey, 2003). Parental wh-questions (e.g., "*What is it*?") utilized during book reading at three years of age have also been shown to improve children's later vocabulary profiles (Blewitt, Rump, Shealy, & Cook, 2009; Senechal, 1997). Wh-questions utilized for the purpose of topic maintenance and continuing conversation (e.g., "*What color is the ball*?" while playing with a ball) increase child response rates during conversation in children with developmental disabilities (Yoder, Davies, Bishop, & Munson, 1994). Finally, the frequency of parental wh-question input to typically-developing children 2-to-3 years of age significantly affects the children's progress in wh-question acquisition as well as overall syntactic complexity of expressive language, additionally suggesting that frequency of adult question input has an effect on linguistic output in typically-developing children (Rowland, Pine, Lieven, & Theakston, 2003). Taken together, research indicates that both frequency and form (Asked and Answered and Wh-questions) of parental question input have effects on children's vocabulary development, syntactic complexity, and social response rate.

The use of pedagogical questions, questions asked by a knowledgeable individual to a less knowledgeable individual for the purpose of teaching, is a technique frequently used by both teachers and parents to elicit critical thinking and learning in children. Asked and Answered (e.g., "*Do you want a ball*? *Here it is*." "*Is this a cookie*? *Yes, it is a cookie*."), wh-questions, and open-ended questions, are all effective forms of pedagogical questioning (Chouinard, Harris, & Maratsos, 2007; Ervin-Tripp, 1970; Rowe, Leech, & Cabrera, 2016). Question use for the function of teaching is common in parent-child interactions with typically-developing children and can show language-facilitating impacts for children as young as toddler age (Yu, Bonawitz,

& Shafto, 2017). Such questions appear to be effective because children are able to interpret joint attention, child-directed speech, and name calling as integrated cues that adults are using in an attempt to teach (Csibra & Gergely, 2009).

The skill areas required to interpret child-directed questions, particularly joint attention, are challenging for young children with autism spectrum disorder (ASD), which makes it unclear whether language enrichment through parental question use is as effective in children with ASD as it is in typically-developing children (Meindl & Cannella-Malone, 2011). Parents of children with ASD have been shown to ask fewer questions than do parents of typically-developing children, possibly due to the use of a more controlling communication style as opposed to the interactive communication style used by parents with typically-developing children (Venuti et al., 2012). Such a style may be necessitated in order to regulate behavior in children with ASD.

Moreover, we do not know whether relative frequency of parental question use with children with ASD is associated with the linguistic development of these children, as it is with typically-developing children. Nor do we have much data on the types of questions children with ASD are likely to hear from their parents. Finally, though we know parental question input effects conversational turn taking in typically-developing children (Yoder, Davies, Bishop, & Munson, 1994), we do not know what, if any, impacts that parental question input may have on the development of social responsiveness in children with ASD. Investigating the linguistic and social effects of the frequency and form of parental question input for children with ASD can increase understanding of how to promote linguistic growth in these children. This process can in turn better shape intervention protocols to utilize the most effective form of child-directed speech to best improve language development in children with ASD.

Treatment of Autism Spectrum Disorder

According to the most recent statistics, 1 in 59 children in the United States is diagnosed with ASD (U.S. Centers for Disease Control and Prevention, 2018), a disorder characterized by repetitive/ restrictive behaviors and interests, and difficulty with social communication (American Psychiatric Association, 2013). While early intervention services are frequently sought for children on the spectrum to improve functioning (Itzchak & Zachor, 2009; Rogers & Vismara, 2008; Warren et al., 2011), the literature is divided in regard to which type(s) of intervention are the most effective (Dudzinska, Szymona, Pacian, & Kulik, 2015; Tachibana et al., 2017; Itzchak & Zachor, 2011). Evidence remains limited for many treatment approaches, particularly those that are parent-implemented (Camarata, 2014). Intervention programs are often a combination of differing techniques, which presents a challenge in determining the mechanisms by which any improvements are achieved.

Language impairment, while not a core deficit of ASD, is a common characteristic of individuals on the spectrum that is often targeted in early intervention. On average, individuals with ASD fall 1.5 standard deviations below the average of their typically-developing peers in standardized assessments of expressive and receptive language (Kwok, Brown, Smyth, & Cardy, 2015). Language deficits in individuals with ASD have been found in all domains, including syntax, morphology, semantics, and pragmatics (Eigsti, Marchena, Schuh, & Kelley, 2001; Rapin & Dunn, 1997). Many evidence-based early intervention treatments have been shown to produce significant improvement in language skills in children with ASD (Koegel, O'Dell, & Dunlap, 1988; Koegel & Koegel, 1988; Lovaas, 1987; Rogers, 2005; Rogers & Vismara, 2008); however, it is unclear which interventions are the most effective and which components of a complex intervention program produce positive results (Warren et al., 2011).

Most interventions for ASD target language at an early age, as the presence of spoken language predicts better developmental outcomes in later childhood and adulthood (Gillberg & Steffenburg, 1987; Howlin, Goode, Hutter, & Rutter, 2004; Venter, Lord, & Schopler, 1992). Increasingly, parent-implemented interventions and trainings have been developed to allow for easier implementation, more intensive dosage, increased generalization, and reduced costs of intervention (Oono, Honey, &McConachie, 2013). There is evidence that linguistic aspects of caregiver input have an effect on language acquisition in children with ASD (McDuffie & Yoder, 2010; Swensen, Naigles & Fein, 2008). As previously stated, research indicates parental question use is effective for improving language skills in typically-developing children. Thus, it is not surprising that structured parental question use, or question input, is a strategy taught to caregivers in many early interventions for ASD; however, little research has been conducted on its effectiveness.

Use of Questions in Interventions for ASD

Recommended utilization of questions by parents and providers to develop language in children with ASD varies across many treatment interventions. For example, Enhanced Milieu Training (EMT), a child-centered treatment intervention, does not promote the use of questions in parent trainings. Question use is to be avoided, other than during requesting, in order to motivate the child to initiate conversations, rather than passively respond (Roberts, Kaiser, & Wright, 2010). While requesting, the parent can also prompt the child to request by asking an open-ended question (e.g., "*What do you want*?") or asking a question with a choice (e.g., "*Do you want the bubbles or the car*?"). On the other hand, structured behavioral interventions, such as Applied Behavioral Analysis (ABA), utilize questions as a stimulus to obtain a desired response. Children are asked questions (e.g., "*What is it*?") and are trained to respond correctly.

Questions are not to be asked if the child is not expected to answer, as this will train the behavior of non-responsiveness. The Play and Language for Autistic Youngsters (PLAY) Project Home Consultation model (Solomon, Necheles, Ferch, & Bechman, 2007) trains parents to present specific forms of questions while interacting with their child with ASD to increase the development of vocabulary, increase grammatical complexity, and create reciprocal communication exchanges. The PLAY project promotes the use of two types of questions: the Asked and Answered technique to improve vocabulary development, and wh-questions to increase grammatical complexity of the child's expressive language and conversational turn-taking.

The discrepancies among interventions on the recommended utilization of adult child-directed questions should motivate research on how questions directed to children with ASD (and their appropriate form and frequency) promote language development. Data from the PLAY Randomized Controlled Trial (RCT; Solomon, Van Egeren, Mahoney, Huber, & Zimmerman, 2014), the largest trial of parent-implemented DIR-Floortime therapy to date, can be used to inform some of these gaps in our knowledge base.

The remainder of the introduction will further introduce the PLAY project and its origins, expand on the form and function of parental questions taught in the PLAY project, and hypothesize possible linguistic outcomes for children with ASD as a result of parental question input.

PLAY: a DIR/ Floortime treatment for ASD

Child-centered intervention approaches are a form of early intervention driven by a child's interests for the purpose of increasing engagement and language generalization for the child. Adults are expected to follow the child's lead, targeting social communication exchanges

in a naturalistic, real-life environment with goals based on expected developmental milestones. The Play and Language for Autistic Youngsters (PLAY) Project Home Consultation model (Solomon, Van Egeren, Mahoney, Huber, & Zimmerman, 2014) is a recently developed, child-centered, home-based early intervention approach based on the principles of Developmental, Individual-differences, Relationship-based (DIR/Floortime) Therapy. Parents are trained in effective engagement techniques to be used during play that are hypothesized to increase social interaction, improve language development, and decrease the maladaptive behaviors and symptoms of ASD in their children.

DIR/ Floortime therapy, originally created by Stanley Greenspan (1992), has served as a model for many other child-centered interventions for children with ASD, including the PLAY Project. DIR/Floortime is structured to fit a child's individual needs and interests as the child progresses through six functional, developmental milestones. The goals of the intervention are to improve children's ability to relate to others, think creatively and logically, and communicate with purpose and meaning (Greenspan & Wieder, 2006). Creating "circles of communication," or initiating reciprocal exchanges that are contingent and enjoyable, is a principle utilized to increase child engagement. Clinicians and parents join in the child's play in a natural environment and imitate and elaborate on the child's play actions to create communicative temptations that will encourage the child to open a circle of communication. DIR/ Floortime has been shown to be effective in increasing social interactions, communicative exchanges, peer relationships, empathy, and creative thinking in children with ASD (Dionne & Martini, 2011; Greenspan & Wieder, 1997, 2005). Additionally, home-based, parent implemented DIR/ Floortime interventions have been shown to improve communication in children with ASD (Liao et al., 2014; Oono, Honey, &McConachie, 2013).

PLAY Project Techniques and Strategies

Guidelines and strategies for implementation of the PLAY Project are provided to parents in a written manual, are modeled by consultants during 3-hour home visits, and documented in the book *Autism: The Potential Within* (Solomon, 2016). Implementation is based on utilizing strategies and skills during PLAY sessions that promote increased engagement and interaction with a child on the spectrum.

Asked and Answered is the first question-based technique used for preschoolers who are in the first through fourth functional developmental level. Asked and Answered is a technique developed to improve and expand child language through the use of "salient language", a key feature of the PLAY project. The PLAY project defines salient language as concrete, consistent labels for objects or activities that are to be used and repeated across caregivers and settings. Parents are instructed to ask the child a question (i.e., "*Do you want the ball?")* and then answer the questions themselves (i.e., "*Here is the ball*.") This allows the child to hear the vocabulary word twice, creating stronger linguistic mapping. The PLAY project advises that the use of questions of any form other than "Asked and Answered" should be limited for this developmental group, and that comments should be used to engage the child during play, rather than questions.

As children reach the higher developmental levels of four through six, the form of questions is expected to evolve to wh-questions that the child directly answers. Parents are instructed to begin to incorporate wh-questions to improve the child's conceptual understanding and both concrete and abstract reasoning. Typical linguistic development patterns are to be followed in asking wh-questions, regardless of a child's chronological age. Wh-questions asked should begin with concrete "what" and "where" questions (e.g., "*What color is this?"* or "*Where*

is your coat?"), before progressing to open-ended "what" questions (e.g., "*What should we do next?")*. Once the ability to answer basic wh-questions has been acquired, "when" questions should be introduced (e.g., "*When do you brush your teeth?*"). Asking "why" questions (e.g., "*Why do you wear a coat*?"), is the final level of input to be introduced as the child develops. By introducing new types of questions, children theoretically will also be exposed to different grammatical forms and linguistic structures, which are presumed to increase the grammatical complexity of the child's spoken language (Goodwin, Fein, & Naigles, 2014; Rowland, Pine, Lieven, & Theakston, 2003.)

Evaluation of outcomes of PLAY intervention

In a pilot study (Solomon, Necheles, Ferch, & Bechman, 2007), 68 children previously diagnosed with ASD, ages 18-months to 6 years, completed the PLAY program over an 8-12-month period. *Functional Emotional Assessment Scale* (*FEAS*; Greenspan, DeGangi, & Wieder, 2001) scores pre- and post-PLAY revealed that approximately 50 percent of the participants made good to very good functional developmental gains (Solomon, Necheles, Ferch, & Bechman, 2007). In a PLAY Project randomized controlled trial (RCT), perhaps the first major RCT of a DIR/Floortime intervention, 128 children previously diagnosed with ASD, ages 2 to 5 years were randomly assigned to comparison (treatment as usual) or PLAY treatment groups (Solomon, Van Egeren, Mahoney, Huber, & Zimmerman, 2014**).** Each intervention was carried out over 12 months, with a home consultation visit once a month for 3 hours. Parents were expected to perform PLAY therapy with their child in 15-to-20-minute play sessions for a total of two hours a day. Pre-intervention and post-intervention videos were collected. The *Autism Diagnostic Observation Schedule* (*ADOS-G*; Lord, Rutter, DiLavore, & Risi, 2003), the *Social Communication Questionnaire* (*SCQ*; Rutter, Bailey, & Lord, 2003), and the *FEAS* were used to

compare the treatment groups pre- and post-intervention. PLAY intervention resulted in significant improvements in parent-child interactions and decreased autism-related diagnostic symptoms as compared to the comparison group. However, no difference in language was seen in the children who received PLAY therapy in comparison to the children who received standard clinical services. Both groups improved language scores over the year (as measured by the *Mullen Scales of Early Learning* (Mullen, 1995) and the *MacArthur-Bates Communicative Development Inventories [MCDI]*); however, large numbers of children did not have scores at both measurement points, lowering statistical power. For the *Mullen Scales*, 20% of the participants at baseline and 17% of the participants at post-intervention were unable to complete the assessment due to low cognitive and developmental function. The *MCDI* was only completed by 51% of parent participants by end of study, and relied on parental reporting to document and track language development. A secondary analysis of the RCT data found that children's increased social engagement was mediated by increased parental responsiveness; thus, behaviors taught to parents appeared to directly facilitate children's social development (Mahoney & Solomon, 2016).

Pilot analysis of the PLAY early intervention program's language outcomes was done using transcript data from 22 participants and revealed that linguistic improvements were seen in children who participated in the program when natural language sample analysis was conducted (Catalano, 2016). Natural language samples are an effective, ecologically valid form of assessment for expressive language and communicative behaviors, revealing more than standardized assessments or parent reports alone (Tager-Flusberg et al., 2009; Wilson, Blackmon, Hall, & Richoltz, 1999). Children who received PLAY project intervention showed a significant increase in verbal initiations and responses compared to pre-intervention (Catalano,

Ratner, & Solomon, 2016). Word production (as measured by total number of words and number of different types of words), grammatical complexity (as measured by mean length of utterance [MLU] and The Index of Productive Syntax [IPSyn] scores), and total number of utterances significantly improved, and an increase in social interactions was seen. Significant lexical growth (as measured by Vocabulary Diversity [VOCD] and the number of different words in 100 words [NDW]) was not found, when the two treatment arms were compared. In the PLAY treatment group, mothers' responsiveness to the child's conversational bids also improved, which decreased child non-engagement. Overall, significant linguistic development and social interaction improvements were observed in a language sample analysis of the PLAY treatment group, even though differential improvements between the treatment and comparison group were not found on standardized assessments administered in the original RCT.

Further research and language sample analysis using 43 participants in the PLAY group and 37 participants in the treatment-as-usual group revealed that significant language improvements were seen in children enrolled in the PLAY project and these improvements were comparable to the language improvements seen in children in the comparison group receiving standard services (Dominguez, Garbarino, Ratner, & Solomon, 2018), using the measures as length of utterance in morphemes (MLUm) ($t=-2.626$, $p=.014$) , Types-Number of different words ($t=-2.571$, $p=.012$) and Tokens-Number of words in total ($t=-3.391$, $p=.002$). Child language improvements were seen in the PLAY intervention, raising the question of which parent techniques are associated with child language growth. No previous studies have explored parental question use and its association, if any, with child language growth.

Research Questions

In the current study, previously collected pre-and post-treatment natural language samples from the PLAY Project RCT were analyzed through the use of CHILDES transcription and CLAN analysis software to assess how parental question use impacts language development in children with ASD. By investigating the form of parental question use promoted in the PLAY Project, we will assess if the PLAY program increases the frequency of question-related parent-child interactions in comparison to parents who did not receive PLAY training.

The first goal of this language study is to establish how the use of questions changes in parents who have been trained in the PLAY intervention in comparison to those who have not been trained. This will assess the effectiveness of the intervention in training parents to implement program strategies. We predict that the form of questions utilized by parents trained in PLAY will be primarily wh-questions, as developmentally appropriate for the child, and that the number of wh-questions and Asked and Answered questions will increase in trained parents.

The second goal of this study is to assess the effect of parental question use on lexical growth, grammatical complexity of spoken language, and social turn taking in children with ASD. Little research has been conducted on how the proportion and form of parental question input relates to language development in children with ASD. We will assess how the proportion and form of parental questions relates to child expressive vocabulary, grammatical complexity, and social turn taking after one year of treatment.

We hypothesize that a higher proportion of parental question input (regardless of group) will be associated with greater linguistic and grammatical complexity in the child's language at study end. We hypothesize that growth in parental use of questions in the form of Asked and Answer will be associated with greater lexical growth and structural complexity of expressive

language in children. We hypothesize that higher parental use of wh-questions during play interactions will be associated with greater vocabulary development in children. However, we additionally hypothesize that children may be less responsive when their parents utilize wh-questions, as a result of the relative complexity of such questions. In summary, the major research questions of the current study are:

1. Does the PLAY program effectively teach and implement question utilization strategies by parents in the intervention group as compared to parents who did not receive PLAY training?
2. How does the growth in proportion of parental questions over all parental utterances affect linguistic and communicative outcomes in children with ASD?
3. How does parental question input in the form of Asked and Answered or wh-questions affect linguistic outcomes in children with ASD?

Chapter 2: Methods

Intervention Method

This study used data originally collected by Dr. Richard Solomon and colleagues during the RCT of the PLAY program. In the RCT study, 128 children (age 32-71 months at baseline) previously diagnosed with ASD (*DSM-4* Criteria) were recruited from local physicians in 5 U.S cities to participate. The children were randomly divided into two cohorts; an experimental group who received the PLAY program intervention services and the comparison group who received standard public education-based community services. Pre- and post-treatment video samples of natural play between the child and his/her primary caregiver were obtained for both treatment groups.

Each family in the treatment group was assigned a PLAY program consultant who facilitated participation in the program and trained the parents in PLAY program intervention techniques. Parents participated in a video orientation and were provided with written guidelines that detailed the 6 functional developmental levels of DIR/ Floortime and principles, techniques, and methods of the PLAY program. PLAY consultants provided 3-hour monthly home visits for 12 months to train the primary caregiver through modeling, coaching, and video feedback. Consultants modeled PLAY techniques and coached caregivers on how to engage and challenge the child while expanding their interactions. Home consultants obtained a video sample of naturalistic play interactions between the child and caregiver, then provided written feedback on strategies to increase engagement. The caregivers were instructed to engage their child in 15-to-20-minute play sessions using the provided techniques and methods for a total of 2-hours a day. Fifteen-minute parent-child play interactions were recorded pre-and-post intervention for both groups to assess PLAY Project outcomes.

Participants

For this study, 80 child-parent pairs and their corresponding pre-and-post treatment videos from the original sample were available for transcript analysis. Participants with unusable pre-and-post treatment videos were excluded for various reasons (e.g., caregiver switched between recording session, quality of audio/video). All children were previously diagnosed with autism spectrum disorder, as confirmed by scores on the *Autism Diagnostic Observation Schedule-Generic* (*ADOS-G*), the gold standard assessment for ASD diagnosis, and the *Social Communication Questionnaire* (*SCQ*), a parent report measure. In both the treatment and comparison group, pre-intervention language skills ranged from no spontaneous language production to spontaneous verbal language production with impaired pragmatic skills.

Children in the study were assigned to a low language group or a high language group based on the *ADOS-G* module they were administered during their entrance into the original RCT. The *ADOS-G* has five modules that are administered based on child communication ability and language profile. The *ADOS-G* module one was administered to children with minimal to no verbal language pre-intervention. The *ADOS-G* module two was administered to children who were able to combine words and produce phrased speech. Children were divided into the low group if they were administered module one or the high group if they were administered module two.

Children ranged in age from 32 months to 71 months at pre-intervention, with a mean age of 50.68 months and a standard deviation of 9.75 months. Forty-three parent-child pairs from the PLAY treatment group had transcripts eligible for analysis (38M, 5F), with 31 children in the low language group and 12 children in the high language group. Thirty-seven parent-child pairs from the comparison group had transcripts eligible for analysis (33M, 4F), with 26 in the low

language group and 11 in the high language group. There were no significant differences between the PLAY group and comparison group in regard to gender, child age, or language level. At an alpha of .01 adjusted for the multiple analyses, there were no significant differences in the language measures (Types, MLU, VOCD, IPSyn, MLT) of the two groups at pre-intervention. No significant differences were found between the PLAY and comparison group in pre-intervention language measures, gender, or child age when divided by language level (low/high).

Differences Between PLAY and Comparison Group- Whole Group

Variable	Gender	Age	Lang. Level	Types	MLU	VOCD	IPSyn	MLT
t	-.114	-.115	-.177	-.719	-7.31	-2.106	-1.059	1.345
p value	.910	.909	.860	.474	.467	.05	.298	.182

Differences Between PLAY and Comparison Group- Low Language Group

Variable	Gender	Age	Types	MLU	MLT
t	-.154	.160	-.863	-1.87	.883
p value	.878	.874	.392	.067	.381

Differences Between PLAY and Comparison Group- High Language Group

Variable	Gender	Age	VOCD	IPSyn	MLT
t	.062	-.401	-1.494	.191	1.38
p value	.952	.692	.15	.851	.182

Of the 80 child participants, a fifth identified as African-American, Asian, and/or Hispanic. Half of the parents had at least an associate's degree, more than half of the parents reported family incomes less than $60,000, and most of the children were from 2-parent households.

Procedures

Fifteen-minute mother-child play interaction videos acquired during the PLAY project RCT were transcribed by CITI-credentialed undergraduate and graduate students from the University of Maryland. The transcribers were blind to treatment group and time (pre- or post-

treatment). CHILDES CHAT protocols (MacWhinney, 2001) were used to transcribe both mother and child verbal and non-verbal interactions. A total of 34,346 parental utterances and 11, 248 child utterances were analyzed.

Transcripts were coded for parental question form. All child-directed, answerable (e.g., non-rhetorical) questions were coded. First, the proportion of questions over total utterances was found for each parent. Then, the proportion of the specific question types (Asked and Answered/wh-questions) over total questions was determined.

The behavior of the child was coded to establish the child's responsiveness to parental communication bids. Responses were coded as either verbal or non-verbal and included any communicative gesture, facial expression, or vocalization that appeared to close a circle of communication. Behaviors that followed a parental communicative bid, including answering a question, making a comment, answering a call for attention, making eye contact, or following directions were coded as a response. Alternating communicative exchanges were continually coded as responses until a new topic was initiated (e.g., introducing a new toy).

Language and communicative measures: Parents

Comparisons between treatment and comparison groups were analyzed by finding the change in proportion of parental question use in pre-and-post-intervention. Parental input was assessed for proportion of questions over total utterances. The proportion of parental questions that were Asked and Answered and the proportion of parental questions that were wh-questions were found for both the treatment and comparison group.

Language and communicative measures: Children

Changes in child language growth were determined using multiple measures for lexical growth and grammatical complexity of spoken language. The child's verbal and non-verbal

behaviors were measured to determine change in communicative participation pre-and-post-intervention. Children were assigned to a low or high group as described earlier.

Vocabulary measures: One measure of linguistic growth that was utilized was Vocabulary diversity (VOCD; Malvern, & Richards, 2002), which uses repeated random samples of words from a transcript and assesses them for diversity based on distinct lemmas. VOCD is a reliable measure of lexical diversity in the speech of higher functioning children (Durán, Malvern, Richards, & Chipere, 2004). VOCD cannot analyze short language samples from those who are lower functioning, as it requires a minimum of 25 utterances. For the low group, number of different words types (Types, based on lemmas) during the play session was utilized to measure vocabulary growth. Changes in child lexical growth were measured by comparing VOCD for children in the high language group and word Types for children in the low language group from pre- to post-intervention.

Grammatical measures: Grammatical complexity of spoken language was measured by utilizing two indices of child language growth. The Index of Productive Syntax (IPSyn; Scarborough, 1989), which computes a score based on the presence of 60 specific grammatical elements, was used as an assessment measure. Though IPSyn has recently been adjusted to require fewer (50) utterances than its prior formula (Altenberg, Roberts, & Scarborough, 2018), many children still did not qualify for this language measure. For individuals with less advance language skills who did not qualify for IPSyn, Mean Length of Utterance (MLU; Brown, 1973), a widely used measure of early child language complexity, was used. Changes in child grammatical complexity were measured by utilizing MLU in morphemes and IPSyn scores (Scarborough, Rescorla, Tager-Flusberg, Fowler, & Sudhalter, 1991) from pre- to post-intervention.

Turn-taking measures: Conversational turn taking was measured utilizing Mean Length of Turn (MLT). The number of conversational turns and the average length of conversational turns was computed.

Change in Parent and Child Behavior

Changes in parent behavior and child language abilities pre-and post-intervention were measured by deducting pre-intervention scores from post-invention scores. This measure provided insight into the directionality of behavior and language changes, as both positive and negative scores were possible.

Analysis

This study utilized a pre-post experimental design. To answer the first research question of whether parental question use changed before and after treatment in the two groups, a series of repeated measures analysis of variance (ANOVA) were used, with treatment group as a between-group factor, and time (pre-post) as a within-subjects factor. We first assessed the change in proportion of all questions asked, then proportion of Asked and Answered questions, then proportion of wh-questions across groups to determine if significant changes were seen in parental question use. Analyses were run separately by language group to determine if differences were seen based on the communicative level of the child.

Spearman's Rho was used to answer the second and third research questions of whether greater parental question input, parental Asked and Answered input, or parental wh-question input was associated with higher child vocabulary, grammatical complexity of spoken language, and/or conversational turn-taking profiles. The analyses were first conducted to assess the relationship between parent input and child language abilities at baseline, regardless of treatment group, to gain insight into trends in the general ASD population. Analyses were then conducted

by treatment group to assess the relationship between change in parent input and change in child language abilities from pre-to post-intervention. Relationships between parental questioning and child language measures were analyzed regardless of child language level, then by child communicative level (high-low) to determine if differences were seen based on child linguistic abilities. Given multiple analyses, we used the Holm-Bonferroni adjustment to reduce alpha appropriately for this and other statistical analyses.

Reliability

Transcripts were analyzed by a second coder to establish reliability of coding. Twenty percent of the transcripts were coded by the second coder. These transcripts consisted of both the comparison and PLAY group in both pre-and post-intervention. Reliability was determined for the proportion of question input to total utterances, the proportion of questions that are Asked and Answered, and the proportion of questions that are wh-questions. Pairwise correlations were conducted to establish reliability. Correlations ranged from .572 to .942. Proportion of questions to total utterances ($p<.001$), proportion of Asked and Answered ($p=.003$), and proportion of wh-questions ($p<.001$) all reached significance, indicating reliability of coding.

Chapter 3: Results

Preliminary Results- PLAY Project Language Outcomes

Before assessing the primary research questions of this study, preliminary analyses were conducted to assess if language improvements were seen in the study population enrolled in the PLAY project using the measures targeted in this study (Types, MLU, VOCD, IPSyn, MLT). Paired-sample t-tests were conducted to assess if the PLAY project effectively improved child language measures. At an alpha level of .05, significant language improvements were seen in child vocabulary and grammatical complexity as measured by Types and MLU, though not in the measures VOCD and IPSyn, likely due to a reduction in power because not all participants qualify for these measures.

Table 1: Child Language Changes from Pre-to-Post Intervention

Measures	Types	MLU	VOCD	IPSyn	MLT
t	2.571	2.626	1.062	.377	16.93
P value	.012	.014	.300	.715	.937

Parental Change Outcomes Pre-and Post-Treatment

Change in parental language input pre-and post-PLAY intervention was compared to the change in language input of parents in the comparison group. A series of repeated measures analysis of variances (ANOVA) were computed to analyze the effect of time and treatment on parental language input.

Proportion of Question Input Pre- and Post-Treatment

First, we assessed the effects of treatment and time on question input in parent participants. The proportion of parental questions to total utterances was computed pre-and post-intervention for the PLAY and comparison groups. The analyses were conducted to first assess treatment effects for the whole group, then to assess treatment effects by child language level

(low/high). As three separate ANOVAs were conducted for parental question input, the significance criterion level was adjusted to .017. For the whole group, a significant treatment group effect was found, [$F(1, 36)=15.247$, $p<.001$] and no time effect was found [$F(1, 36)=.006$, $p=.936$]. A marginal time by treatment effect was obtained [$F(1,36)=5.914$, $p=.02$], which did not reach significance following adjustment (Table 1, Figure 1, Figure 3). Approximately 35 percent of child-directed utterances were questions pre-intervention in both treatment groups. Following treatment, only 30 percent of utterances were questions in the CDS of PLAY group parents, while 42 percent of utterances were questions in the CDS of comparison group caregivers.

As a significant treatment effect was found and differences in the use of questions by treatment group were present, a post-hoc paired-samples t-test was run to assess whether parents in the PLAY group significantly decreased their proportion of question input from pre-to post-intervention without the control group comparison. At an alpha level of .05, there was a significant difference between the proportion of questions used by the PLAY parents pre-intervention ($M=35.76$, $SD= 10.93$) compared to post-intervention ($M= 30.48$, $SD=11.01$) ($t=-2.23$, $p=.015$). PLAY parents showed a significant decrease in their use of questions, contrary to the hypothesis that direct instruction in question use would increase parental questioning behavior.

In the low language group, no significant group effect [$F(1, 18)=6.826$, $p=.018$], time effect [$F(1,18)=1.648$, $p=.216$], or treatment by time effect was found [$F(1, 18)=1.208$, $p=.286$]. In the high language group, no treatment group effect [$F(1, 10)=3.194$, $p=.104$] or time effect [$F(1, 10)=.225$, $p=.645$] were found. A non-significant treatment by time trend for parental question input was observed after adjustment for multiple comparisons [$F(1,10)=6.036$, $p=.034$].

Though not significant at either language level, general decreases in the proportion of question input by parents in the PLAY group as compared to the comparison group were seen.

Table 1: Proportion of Questions out of Total Utterances by Group

Whole Group

Group	Mean Pre	Mean Post
PLAY	35.25	30.34
Control	37.54	42.14

Low Group

Group	Mean Pre	Mean Post
PLAY	34.32	28.02
Control	37.49	36.77

High Group

Group	Mean Pre	Mean Post
PLAY	41.69	35.36
Control	41.39	50.03

Proportion of Asked and Answered Input Pre- and Post-Treatment

Next, change in proportion of parental questions that were Asked and Answered from pre- to post-intervention, based on treatment group, was assessed. The criterion level was set at .017 to accommodate for the three separate ANOVAs conducted for each language group (whole group, low group, high group). A treatment group effect was found in the whole group in that the PLAY group parents utilized Asked and Answered questions more in general [$F(1,36)=7.806$, $p=.008$] (Figure 2), but no time effect [$F(1, 36)=.931$, $p=.341$] or treatment by time effect [$F(1, 36)=.041$, $p=.840$] was found. As Asked and Answered was encouraged only for parents having children in the low language group, differences based on group were assessed. However, no treatment group, time, or treatment by time effects were found for either the low or high language groups.

Table 2: Proportion of Asked and Answered Questions by Group

Whole Group

Group	Mean Pre	Mean Post
PLAY	7.01	6.29
Control	5.16	4.14

Low Group

Group	Mean Pre	Mean Post
PLAY	6.99	8.55
Control	5.63	5.40

High Group

Group	Mean Pre	Mean Post
PLAY	3.52	3.46
Control	3.63	1.63

Proportion of Wh-question Input Pre- and Post-Treatment

Finally, the effect of treatment and time on the proportion of parental questions that were wh-questions was assessed. To assess wh-question use, significance was adjusted from .05 to .017 to control for the three separate ANOVAs conducted for each language group (whole group, low group, high group). In assessing the whole group, no significant treatment group effect [F(1, 36)=1.555, p=.220], time effect [F(1, 36)=1.737, p=.196], or treatment by time effect [F(1, 36)=1.392, p=.246] was found for wh-question input. In assessing the low group, no significant treatment group effect [F(1, 18)=2.983, p=.101], time effect [F(1, 18)=3.435, p=.080], or treatment by time effect [F(1, 18)=3.182, p=.091] were found. Wh-questions were promoted to parents with children in the high group, so it was expected that the proportion in the low PLAY group would not increase. However, even in the high group, no significant treatment group effect [F(1, 10)=1.917, p=.196], time effect [F(1, 10)=.035, p=.855], or treatment by time effect [F(1, 10)=1.465, p=.254] were found.

Table 3: Proportion of Wh-Questions by Group

Whole Group

Group	Mean Pre	Mean Post
PLAY	28.36	28.20
Control	28.31	33.56

Low Group

Group	Mean Pre	Mean Post
PLAY	27.39	27.25
Control	26.78	36.77

High Group

Group	Mean Pre	Mean Post
PLAY	30.24	27.42
Control	30.50	35.45

Parental Question Use and Concurrent Child Language Ability at Baseline

Proportion of Question Input

The goal after assessing how parental question input changed from pre- to post-intervention in the PLAY group and comparison group was to establish how change in parental behaviors from pre- to-post-intervention related to change in child language measures based on intervention. However, before assessing the relationship between change, we analyzed the relationship between parental question input and concurrent child language output at baseline

across treatment groups to assess general trends in the ASD population. Children in both the PLAY and comparison groups were exposed to a wide variety of question input during play interactions. To assess the associations between parental question input and language in children with ASD, all children's language at pre-intervention, regardless of treatment group, was analyzed. This concurrent baseline analysis is seen below.

We first assessed how the proportion of questions to total parental utterances related to concurrent child vocabulary development (as measured by Types (number of different words per session) and VOCD), grammatical complexity of spoken language (as measured by MLU and IPSyn), and social turn taking (as measured by MLT). A Spearman's Rho rank-order correlation was used, as the data were not normally distributed. The Holm-Bonferroni adjustment was used, with the alpha level beginning at .01 for the five measures of child language computed. There were significant positive correlations between proportion of parental question input and both concurrent child Types and MLU at baseline (Table 4). Higher concurrent child vocabulary and grammatical complexity was associated with higher levels of parental questions input at the start of the RCT. No other significant correlations between total parental question input at baseline and concurrent child language were observed.

Table 4: Correlation between Proportion of Parental Questions and Concurrent Child Language Measures at Baseline- Whole Group

Measures	Rho	p Value
Types	.512	.<001*
MLU Morphemes	.307	.006*
VOCD	.137	.348
IPSyN	-.078	.672
MLT	.235	.036

*significant at p=.01

The population was then divided based on child language level (low/high) to assess whether parents were utilizing questions differently based on their child's language level. Alpha

was adjusted to p= .017 to accommodate the three measures of child language assessed per language group. The measures child word Types, MLU, and MLT were utilized for the low group while the measures VOCD, IPSyn, and MLT were utilized for the high group. In the low group (Table 5), a significant positive correlation was found between parental question input and concurrent child Types of words used at baseline (r_s=.337, p<.001) (Figure 4). While some high language measures were associated with high parental question input in the low group, there were no statistically significant associations between parental question input and child language measures in the high group at the start of the RCT (Table 6). While not statistically significant, it is interesting to note that at baseline many associations between frequency of parental questions and concurrent child language measures became negative for the high group.

Table 5: Correlation between Proportion of Parental Questions and Concurrent Child Language Measures at Baseline - Low Language Group

Measures	Rho	p Value
Types	.490	<.001*
MLU Morphemes	.268	.044
MLT	.185	.168

*significant at p=.017

Table 6: Correlation between Proportion of Parental Questions and Concurrent Child Language Measures at Baseline - High Language Group

Measures	Rho	p Value
VOCD	-.192	.381
IPSyN	.226	.382
MLT	-.043	.844

*significant at p=.017

Asked and Answered

Asked and Answered is the linguistic technique of asking a question and providing the answer to increase child exposure to vocabulary and varying grammatical structures. Using all participants' language samples from baseline, we assessed the associations between frequency of parental Asked and Answered input and the same concurrent child language measures outlined

above, using the same statistical measures and significance levels. Significant negative correlations were found between parental Asked and Answered input and concurrent child Types of Words used at baseline (r_s= -.351, p=.001) (Table 7, Figure 5). In general, negative trends were observed between parental Asked and Answered Input and measures of concurrent child language at the start of the RCT.

Table 7: Correlation between Proportion of Questions that are Asked and Answered and Concurrent Child Language Measures at Baseline - Whole Group

Measures	Rho	p Value
Types	-.351	.001*
MLU Morphemes	-.221	.049
VOCD	-.100	.496
IPSyN	.051	.781
MLT	-.138	.224

*significant at p=.01

As the PLAY project promotes Asked and Answered for parents of children in the low language group, further analysis was conducted based on language level. In the low group, negative trends were found between the proportion of parental questions that were Asked and Answered and concurrent child Types, MLU, and MLT at baseline (Table 8); however, these correlations did not reach adjusted significance. This may be a result of the decrease in power when the sample size was reduced by language group. No significant correlations were found between frequency of Asked and Answered input and child language measures in the high group at baseline.

Table 8: Correlation between Proportion of Questions that are Asked and Answered and Concurrent Child Language Measures at Baseline - Low Group

Measures	Rho	p Value
Types	-.266	.045
MLU Morphemes	-.087	.521
MLT	-.201	.189

*significant at p=.017

Wh-Questions

We utilized a Spearman correlation to assess the relationship between frequency of wh-question input and concurrent child language measures at baseline using procedures described in prior sections. We computed correlations regardless of treatment group. No significant correlations were seen in the whole group analysis at the start of the RCT, though positive trends were seen (Table 9). The group was then divided by language level to analyze the relationship between wh-questions and concurrent child language measures at baseline in the low and high language groups. No significant correlations were found between wh-question input and any concurrent child language variables at baseline in either of the language groups. High vocabulary development, grammatical complexity of spoken language, and social turn taking were not significantly associated with high rates of wh-question input at baseline.

Table 9: Correlation between Proportion of Wh-Questions and Concurrent Child Language Measures at Baseline - Whole Group

Measures	Rho	p Value
Types	.152	.179
MLU Morphemes	.071	.531
VOCD	.163	.262
IPSyN	-.143	.434
MLT	.120	.289

*significant at p=.01

Relationships between Change in Parental Behavior and Change in Child Ability from Pre-to Post Treatment

Following baseline analysis of general relationships between parental question input and child baseline language abilities across treatment groups, further analysis was conducted to assess how **change** in parental language input from pre-to post-intervention related to **change** in language abilities of children in the PLAY group and treatment-as-usual group. The relationships

between parental and child change were analyzed separately by treatment group to determine if differences were seen based on intervention.

In the PLAY intervention group, a significant positive correlation was observed between pre-to post-invention change in the proportion of question input and pre-to post-invention change in child word Types (r_s=.508, p=.001) (Table 10, Figure 6). Parents who had the greatest increase in question input from pre-to post-intervention had children with the greatest increase in word types from pre-to post-intervention. However, no significant correlation was seen between the pre-and post-invention change in the proportion of question input and child Types used in the comparison group (r_s=.289, p=.083), revealing a difference in the effect of change between groups.

A positive correlation between pre-and post-invention change in the proportion of question input and child MLU was found in the PLAY group (r_s= .316, p=.039); however, this correlation did not reach significance at the alpha level of .01. No significant correlation was seen in the comparison group for the same measures (r_s=.237, p=.158). These two measures (Types and MLU), were the measures that were significantly correlated in the analysis between overall parent behavior and concurrent child ability at baseline. No other significant correlations were seen in either the PLAY group or the comparison group for changes in the remaining language measures and changes in the proportion of question input.

Table 10: Correlation between Change in Proportion of Parental Questions and Change in Child Language Measures Pre-to Post-Intervention in the PLAY Group

Measures	Rho	p Value
Types	.508	.001*
MLU Morphemes	.316	.039
VOCD	.318	.139
IPSyN	.438	.206

MLT	.085	.587

*significant at p=.01

As only change in child word Types was found to be positively significantly correlated with a change in the proportion of parental questions, a post-hoc analysis was run to assess whether these changes were greater in the low group or high group of the PLAY project. At an alpha level of .05, significant changes in the low group were seen (r_s=.406, p=.039), but significant changes were not seen in the high group.

The relationship of change was further assessed by calculating the correlation between the change in proportion of questions that were Asked and Answered and change in child language measures from pre-to post-intervention. The alpha level was adjusted from .05 to .01, as all five measures of language were examined. In the PLAY group, significant negative correlations were found between increase in Asked and Answered question input and decrease in both child Types (r_s=-.424, p=.005) and child MLU (r_s=-.42, p=.005) (Table 11, Figure 7) from pre-to post-intervention. A higher rate of parental Asked and Answered input from pre-to post-treatment was associated with a decrease in child language sample measures over time. No significant correlations between change in parental Asked and Answered questioning rate and change in child language abilities were seen in the comparison group.

Table 11: Correlation between Change in Proportion of Asked and Answered Questions and Change in Child Language Measures from Pre-to Post-Intervention in the PLAY group

Measures	Rho	p Value
Types	-.424	.005*
MLU Morphemes	-.421	.005*
VOCD	-.136	.535
IPSyN	-.337	.283
MLT	-.250	.105

*significant at p=.01

As change in child Types and MLU were both found to negatively correlate with the change in the proportion of Asked and Answered from pre-to post-intervention in the PLAY group, these measures were further assessed to determine the relationships between change in Asked and Answered and change in child language measures by language level. The alpha level for this post-hoc analysis was adjusted for the two language measures, resulting in a criterion level of .025. In the low group, increase in the proportion of parental Asked and Answered questions was correlated with decreases in both child Types (r_s= -.451, p value=.021) and child MLU (r_s= -.443, p value=.024) from pre-to post-intervention. No significant correlations were seen in the low-language comparison group. No significant correlations between change in parental Asked and Answered input and change in child language measures were seen in the high PLAY or comparison group.

Table 12: Correlation between Change in Proportion of Asked and Answered Questions and Change in Child Language Measures from Pre- to Post-Intervention in the PLAY group - Low Language Group

Measures	Rho	p Value
Types	-.451	.021*
MLU Morphemes	-.443	.024*

*significant at p=.025

Finally, the relationship between change in parental wh-question input and child language abilities from pre-to post-intervention was assessed. No relationships between parental wh-question use and children's language profiles were seen in the baseline analysis in the whole population. Similar results were seen when change from pre-to post- intervention was analyzed. Both in the PLAY and comparison groups, there were no significant correlations between change in parental wh-question input and change in any child language measures (Table 13). No significant correlations were found by language level.

Table 13: Correlation between Change in Proportion of Wh-Questions and Change in Child Language Measures from Pre- to Post-Intervention in the PLAY group

Measures	Rho	p Value
Types	-.064	.683
MLU Morphemes	.088	.577
VOCD	.204	.352
IPSyN	-.128	.725
MLT	-.015	.923

*significant at p=.01

Figure 1.

Parental Question Input ANOVA Results

Source	treatment	time	Type III Sum of Squares	df	Mean Square	F	Sig.
treatment	Linear		1836.595	1	1836.595	15.247	.000
Error(treatment)	Linear		4336.312	36	120.453		
time		Linear	.863	1	.863	.006	.936
Error(time)		Linear	4800.448	36	133.346		
treatment * time	Linear	Linear	837.587	1	837.587	5.914	.020
Error(treatment*time)	Linear	Linear	5098.988	36	141.639		

A significant treatment group effect was found when assessing the change in proportion of parental question input from pre-to post-intervention in the PLAY group as compared to the comparison group. No time or treatment by time effects were found.

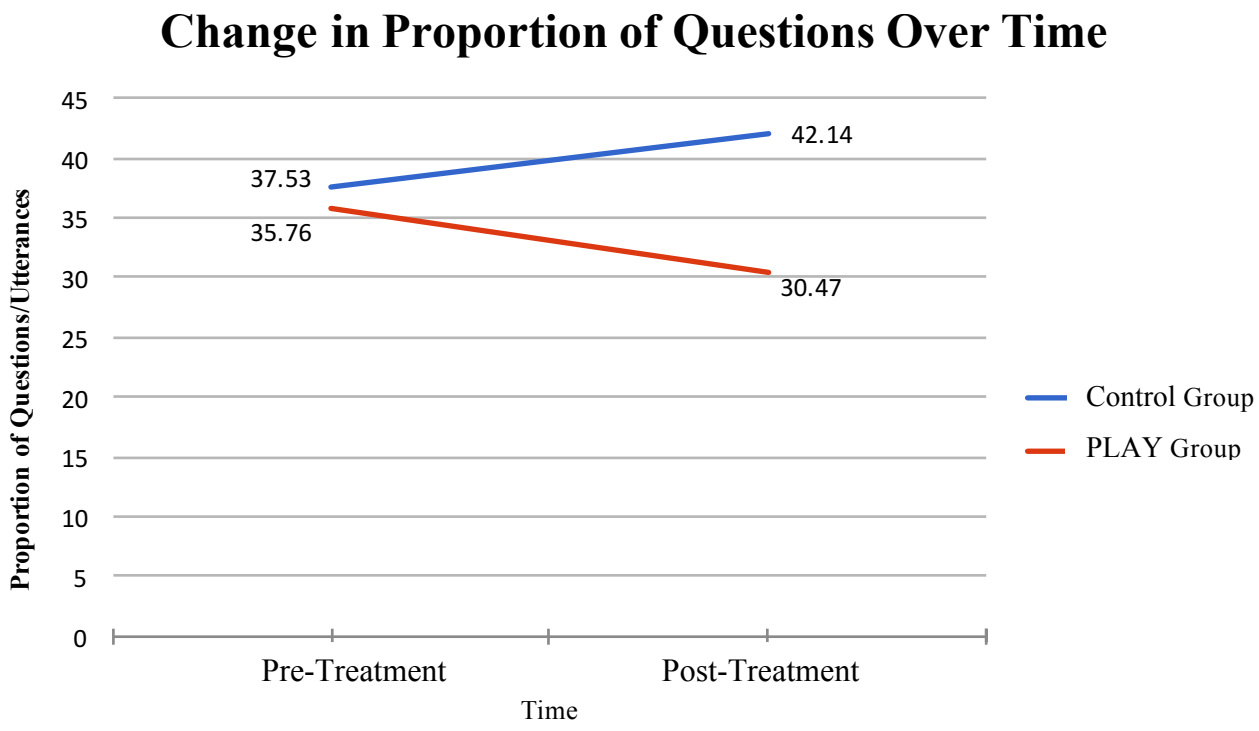
Figure 2.

Parental Asked and Answered Input ANOVA Results

Source	treatment	time	Type III Sum of Squares	df	Mean Square	F	Sig.
treatment	Linear		148.496	1	148.496	7.806	.008
Error(treatment)	Linear		684.798	36	19.022		
time		Linear	27.912	1	27.912	.931	.341
Error(time)		Linear	1078.953	36	29.971		
treatment * time	Linear	Linear	.884	1	.884	.041	.840
Error(treatment*time)	Linear	Linear	767.202	36	21.311		

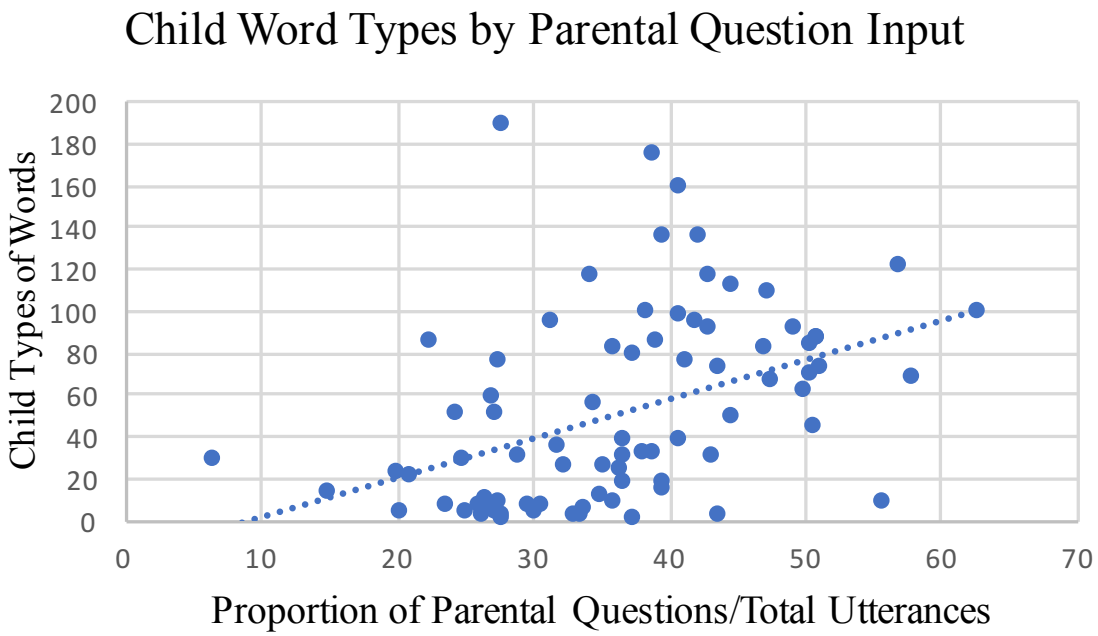
A significant treatment group effect was found when assessing the change in proportion of Asked and Answered question input from pre-to post-intervention in the PLAY group as compared to the comparison group. No time or treatment by time effects were found.

Figure 3.



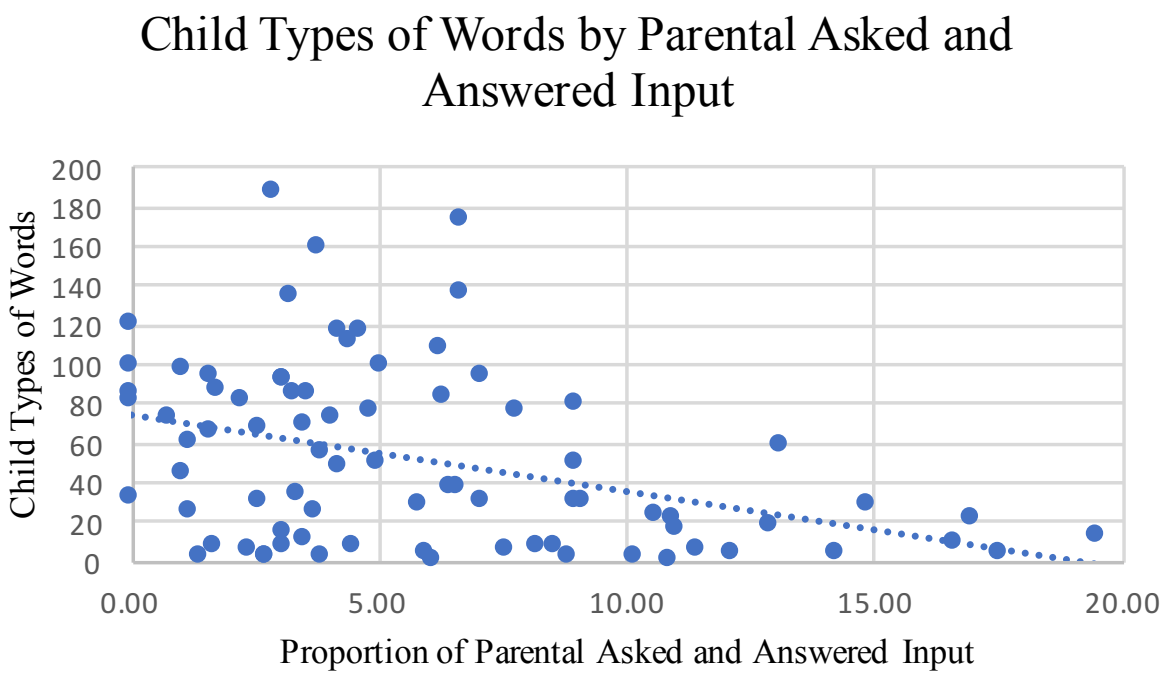
Results of a two-way repeated measures ANOVA assessing the effect of treatment group (PLAY group, comparison group) and time (pre-intervention, post-intervention) on parental question input are seen above. No treatment by time effect was found (f=5.914, p=.02). Though parents in the PLAY intervention significantly reduced their proportion of question input from pre-to post-intervention (t=2.23, p=.014), this change was not significant when compared to the change seen in the comparison group.

Figure 4.



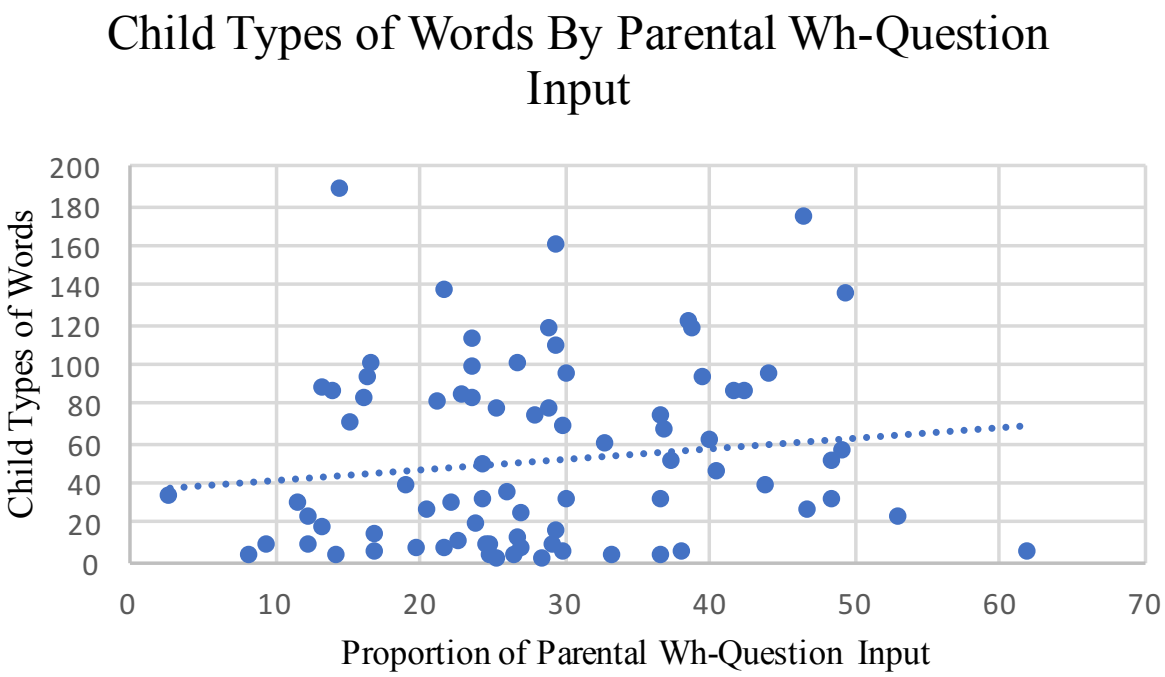
Results of a Spearman rank-order correlation between proportion of parental question input to total utterances and concurrent child Types of words at pre-intervention are seen in Figure 4. A significant positive relationship was found between parental question input and concurrent child Types of words in the whole study population at baseline (r_s=.512, p< .001). High proportions of parental question input were associated with high child vocabulary measures, as well as high child grammatical complexity measures.

Figure 5.



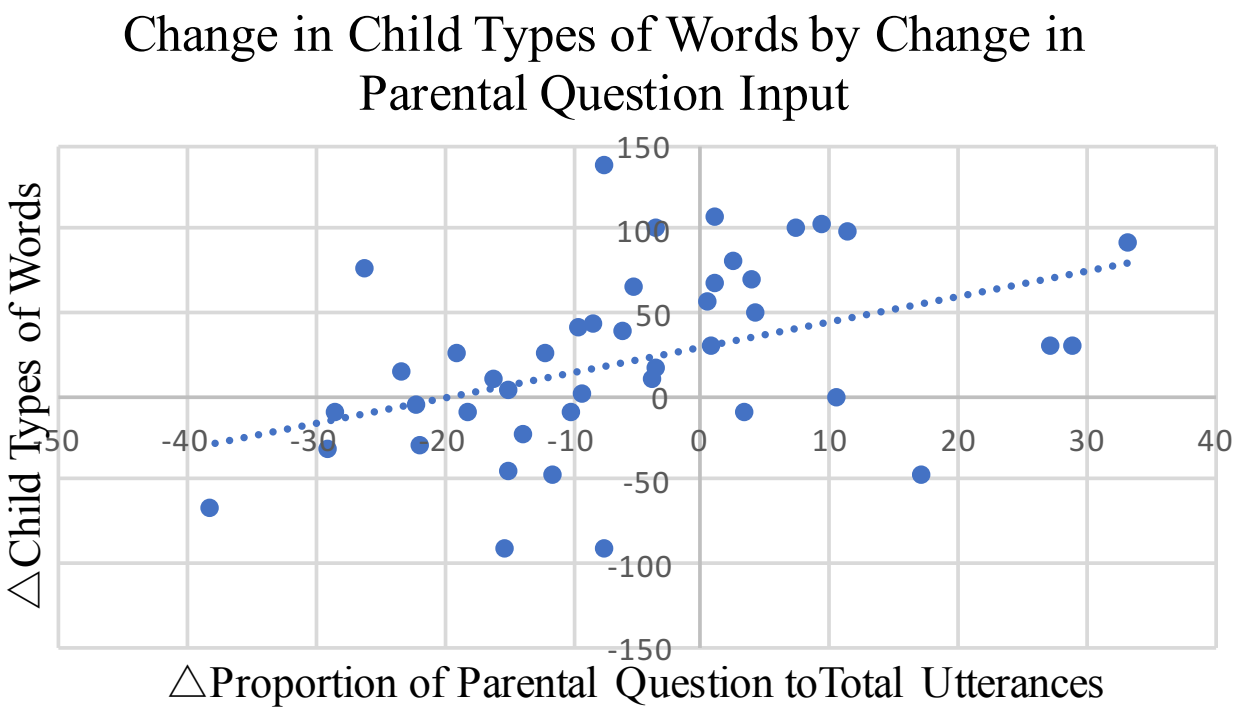
Results of a Spearman rank-order correlation between proportion of parental Asked and Answered question input to total questions and concurrent child Types of words at pre-intervention are seen in Figure 5. A significant negative relationship was found between parental Asked and Answered input and concurrent child Types of words in the whole study population at baseline (r_s=-.351, p< .001). High proportions of parental Asked and Answered input were associated with low child vocabulary.

Figure 6.



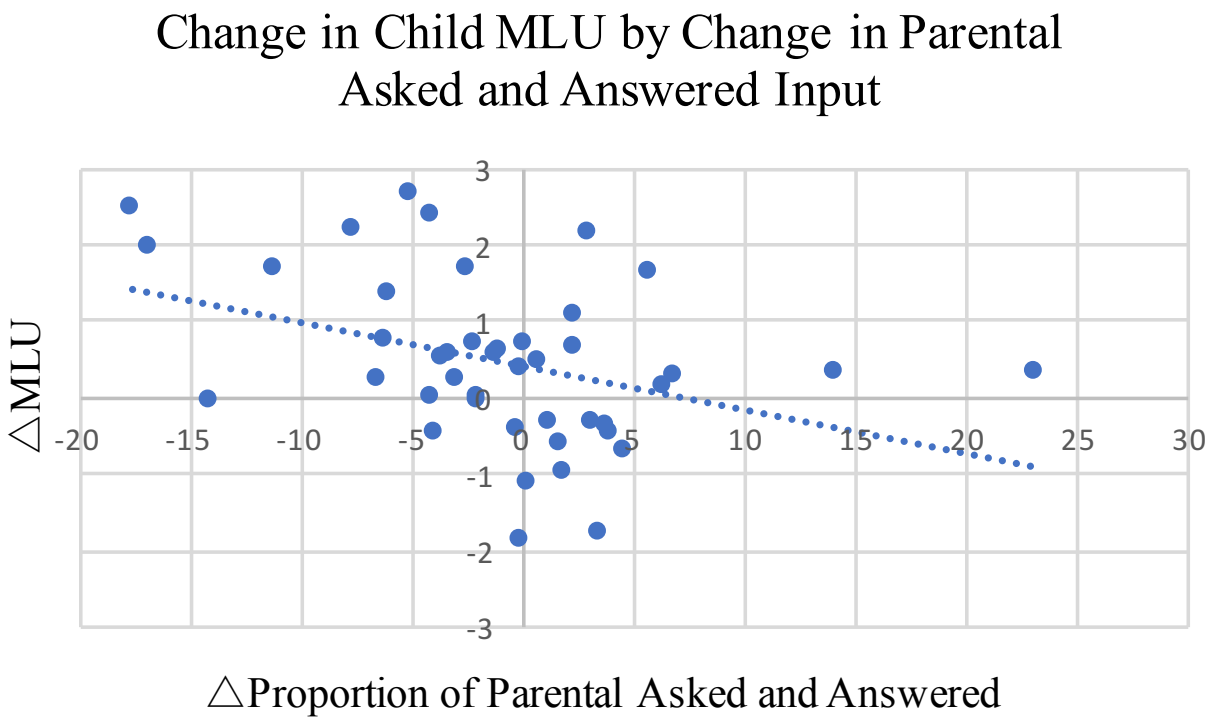
Results of a Spearman rank-order correlation between proportion of parental wh-question input to total questions and concurrent child Types of words at pre-intervention are seen in Figure 6. No significant correlation was found between parental wh-question input and child Types of words, nor any other language measures, in the whole study population at baseline (r_s=-.351, p< .001).

Figure 7.



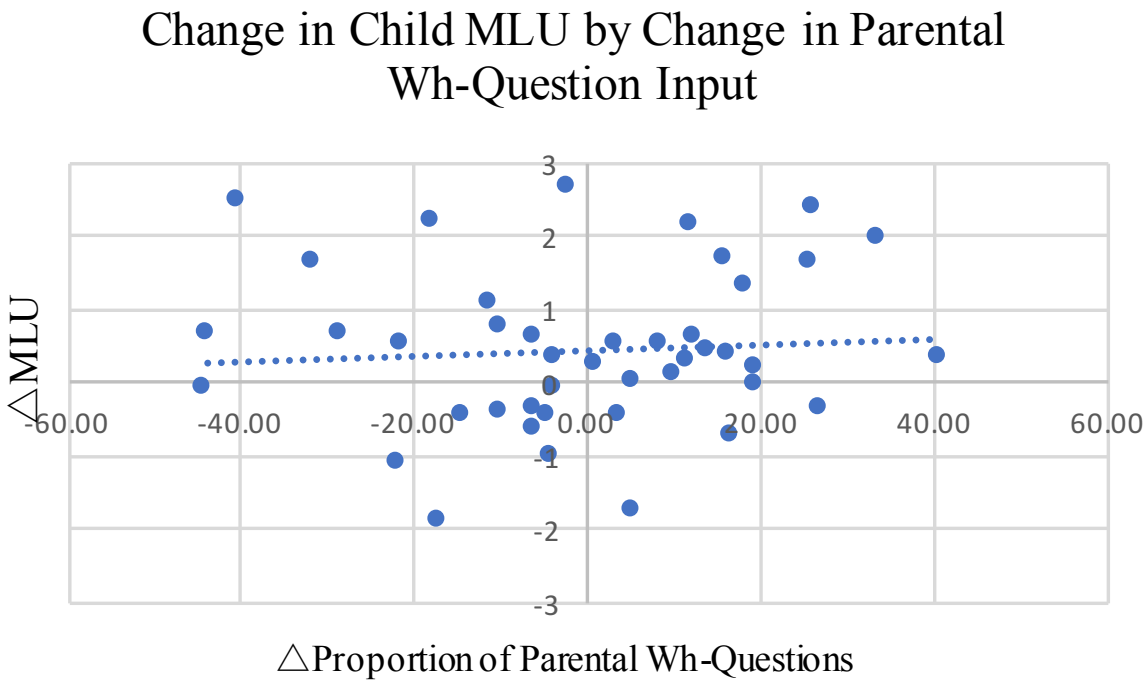
Results of a Spearman rank-order correlation between change of child Types of words and change in proportion of parental question input to total utterances from pre-to post-intervention in the PLAY group are seen in Figure 7. A significant positive relationship was found between change in parental question input and change in child types of words from pre- to post-intervention (r_s=.508, p= .001).

Figure 8.



Results of a Spearman rank-order correlation between change in child MLU and change in proportion of parental Asked and Answered question input to total question input from pre-to post-intervention in the PLAY group are seen in Figure 8. A significant negative relationship was found between change in parental Asked and Answered input and change in child MLU from pre-to post-intervention (r_s=-.421, p= .005).

Figure 9.



Results of a Spearman rank-order correlation between change in child MLU and change in proportion of parental wh-question input to total question input from pre-to post-intervention in the PLAY group are seen in Figure 9. No significant relationship was found between change in parental wh-question input and change in child MLU (r_S=-.088, p= .577). No significant relationships were found between change in parental wh-question input from pre-to post-intervention and change in any child language measures.

Chapter 4: Discussion

Parental Outcomes

This study was conducted to further empirical research on the PLAY project intervention method by establishing whether parental question input encouraged by the PLAY project related to with child language abilities, either at baseline, or post-treatment. The first goal of the study was to establish if the PLAY project effectively taught question utilization strategies to parents in the intervention group as compared to parents who did not receive PLAY training. Overall, the PLAY project encourages a decrease in general question input and an increase in statements and comments that use concrete language. In the original RCT, The PLAY project trained parents in the use of questions only in the forms of Asked and Answered for children with a low language level, classified in this study as the low group, and wh-questions for children with a high language level, classified in this study as the high group. We analyzed change in parental question input over time to determine if differences were seen in child language outcomes over time based on treatment group and child language level.

Overall, our findings suggest the PLAY project accomplished its goal in that parental question usage as a proportion of total utterances significantly decreased from pre-to post-intervention, though this decrease was not significant when compared to the comparison group. Though not significant, it is interesting to assess the different trends that were seen in the PLAY group as compared to the comparison group. Though parents in the comparison group and the intervention group began the study by asking approximately the same proportion of questions, question use in the comparison group increased while question use in the PLAY group decreased. It is possible that in the PLAY group, intervention protocols directed parents to make statements and use salient language to open circles of communication, instead of using questions.

This may explain why changes in parental question input were seen in opposite directions between the PLAY group and the comparison group from pre-to post-intervention.

The PLAY and comparison group were further divided by child language level to determine if parental behavior differed based on a child's functional and linguistic profile. No significant differences in the proportion of question input in the PLAY group as compared to the comparison group were seen at either language level from pre-to post-intervention.

While the PLAY project encouraged the use of Asked and Answered in parents, no significant differences were seen in the proportion of Asked and Answered questions used by the parents in the PLAY group and the comparison group from pre-to post-intervention. No differences were seen in the low language group, which was unexpected, as they were the targeted population for this technique. Similarly, no differences were seen in the high language group, though this was expected, as parents of these children were not instructed to use this technique. Thus, the data would suggest that the strategy of Asked and Answered was not successfully implemented in parents who underwent PLAY training, at least as seen by the post-intervention parent-child play session.

In regard to wh-question use, no significant treatment by time differences were seen between the PLAY group and the comparison group. Similar results were found for both the low language group and high language group. Though the use of wh-questions was promoted in the PLAY project, parents in the PLAY project did not utilize wh-questions significantly more than parents in the treatment as usual group, at least during the post-treatment parent-child language sample.

By establishing the differences in parental behavior pre-and post- intervention in the PLAY group as compared to the comparison group, we were able to assess how effectively the

PLAY project changed parent behavior and implemented parental techniques. In summary, parents enrolled in the PLAY project did significantly decreased their proportion of question input to children, though not at a significantly different level than the comparison group, and parents in the PLAY group did not significantly change their use of Asked and Answered or wh-questions as compared to the treatment-as-usual group, revealing parents in the PLAY project did not appear to be significantly changing their behavior based on these training protocols.

Next, we determined how parental question input related to child language ability and if the techniques presented by the PLAY project were associated with child language growth.

Child Behaviors

Total Question Input

The second research question presented in this study addressed if the rate of parental questioning out of all parental utterances related to linguistic and communicative abilities in children with ASD. This was accomplished in two ways. First, the relationship between parental question input and concurrent child language ability in the general ASD population was assessed by analyzing child language measures at baseline regardless of treatment group, as the effect of parental input would not be expected to differ across groups. Then, the relationship between change in parental question input and change in child language measures from pre-to post-intervention was assessed in the PLAY and comparison group. We were interested in the relationship between parental question input and diversity in child vocabulary, grammatical complexity of spoken language, and turn taking. Our analysis revealed that across treatment groups at baseline, higher proportions of parental utterances that were questions were associated with higher concurrent child vocabulary and grammatical complexity. Directionality of this relationship is unclear; it may be that parents ask more questions of children who have greater

ability to answer them, or that children are prompted to supply more advanced language when challenged to respond to parents' questions.

Next, we assessed whether this relationship differed based on the child's language level. In the low group, high parental question input was associated with high concurrent child vocabulary at baseline. No relationship was found with grammatical complexity at baseline, but this may have been a result of decreased power when the groups were divided. In the high language group, no significant relationships were found between parental question input and concurrent child language measures at baseline. Interestingly, negative trends were seen in the high group. Once again, directionality of these findings cannot be determined: question input may not be effective for exposing children with higher language profiles to new grammatical sentence forms or types of words. Alternatively, parental question use may also elicit simpler language responses than the typical utterances of children in the high group, especially if children used elliptical responses, causing language measures to appear lower than they would if another sample was taken.

Our analysis found that high frequency of wh-question input was not associated with high concurrent child language measures at baseline but general question input was associated with high concurrent child language ability. It is possible that the questions that positively relate to child language measures are yes/no questions that have a more salient use of copula and auxiliary verbs (e.g., "***Is*** *it a boy*?" "***Are*** *you tired*?" "***Do*** *you want it*?") as opposed to wh-questions, due to the placement of the verb. It is possible that the low language group may have benefited more than the high language group from this form of question input because copular and auxiliary verbs are likely still being developed in children with lower language profiles. This may explain why the correlations between proportion of question input and child language

measures were significant or positive for only the low group when the analysis was conducted by language level.

Following the general analysis on the relationship between parental question input and concurrent child language measures at baseline across treatment group, analysis was conducted to assess how these relationships related to parental behavior in the PLAY project. Change in proportion of parental question input from pre-to post-intervention was compared to change in child language abilities from pre-to post-intervention in both the PLAY group and the control group. In the PLAY group, increase in proportion of parental question input was highly correlated with an increase in child vocabulary from pre-to post-intervention. The parents with the largest change in question input from pre-to post- intervention had children who showed the largest increases in types of different words used. This reflects a similar finding to that of the whole group analysis, further confirming that high proportion of parental question use is associated with increases child vocabulary. A positive relationship was also found between change in parental question use in the PLAY project and change in child grammatical complexity, though this relationship did not reach significance. However, in the control group, no correlations were seen between the change in parent question use and change in child language measures. The questions that parents in the PLAY project utilized were associated with more language gains than the questions that parents in the comparison group utilized, possibly because the questions used by the parents in the PLAY project used more salient, concrete language or related to what the child was doing, as was encouraged in the PLAY project.

High question input has been associated with high child language measures in typically developing children (Blewitt, Rump, Shealy, & Cook, 2009; Senechal, 1997; Walsh & Blewitt, 2006; Wasik & Bond, 2001); however, it was unclear whether parental questions showed similar

relationships in the speech of children with ASD. The results of this study suggest that at baseline and in the PLAY project over time, greater use of parental question input is also associated with higher language abilities in children with ASD, particularly for children with low language profiles.

Asked and Answered/ Wh-Question Input

The third research question sought to answer how parental question input in the form of Asked and Answered questions or wh-questions relates to linguistic abilities in children with ASD. This was done by first assessing the relationship in the general population, looking at child language at baseline across treatment groups, then by assessing the relationship between change from pre-to post-intervention in the separate treatment groups.

In analyzing the relationship between proportion of Asked and Answered input and concurrent child language measures across treatment group at pre-intervention, negative correlations were found for the whole group as well as the low language group. High utilization of the Asked and Answered technique by parents was associated with low concurrent vocabulary and grammatical complexity in children at baseline. This may be explained by the deficits associated with ASD. As children with ASD often have difficulty interpreting child-directed speech and joint attention (Meindl & Cannella-Malone, 2011), Asked and Answered may not be an effective strategy for developing child language profiles. Asked and Answered requires that a child is able to interpret that a parent is directing speaking to her/ him, even though the parent is both asking and answering the question. A child with ASD may not understand this child-directed input and may not be receptive to the benefits of increased exposure to varying sentence structures and vocabulary. Asked and Answered often utilizes joint attention to enhance vocabulary, such as holding a book and saying "*What is it? It's a book*" or pointing to a cookie

and stating "*Do you want the cookie? Here's the cookie*." A child with ASD may not direct appropriate attention towards an object and may be less able to interpret the connection between the object and its label.

After assessing the associations between Asked and Answered input and concurrent child language in the whole study population at baseline, the relationship between change in parental Asked and Answered input and the change in child language measures from pre-to post-intervention in each treatment group was assessed. In the PLAY group, increase in proportion of parental Asked and Answered input from pre-to post-intervention was correlated with decreases in measures of child vocabulary and grammatical complexity.

One of the main goals of the PLAY intervention is to increase the number of communication circles that a child enters. Typically, a parent is encouraged to make a communicative attempt to their child to open a new circle that the child can then close in either a verbal or non-verbal manner. With the Asked and Answered technique, a parent both opens and closes a circle. This decrease in communicative opportunities provided by the parent may have caused children in the PLAY project to learn the behavior of non-responsiveness. The children were not held responsible for answering the questions, which may have caused their verbal output, both in the form of their vocabulary and grammatical complexity, to decrease, at least from pre-intervention recording to the post-intervention parent-child session. Relative language gains may have been absent because children were responding and utilizing language less overall in the post-session than the pre-session.

Recognizing that these data are correlational and cannot determine direction of causation, it is still instructive to look at the pattern of results. We must consider whether child output varied because of parent input, or whether parent input varied because of child output.

Alternatively, parental question input may have facilitative impacts on child language, but these must be observed in a different sampling context, rather than when the child provides potentially elliptical answers to the parents' questions. Analysis of child linguistic change from pre-to post-intervention, as shown in Figure 8, suggested that many children in the PLAY project actually demonstrated less mature language profiles over time when parent Asked and Answered input increased. As there was a year between pre-and post-treatment, it is expected that natural language gains and language development would occur, even without the presence of intervention. It seems possible that as children with ASD were exposed to a greater proportion of Asked and Answered in this recorded play session, they were required to answer fewer questions because their parents were answering the questions for them, so measures of their language production decreased in this sample, suggesting that parental input was driving child output during the recording sessions.

Next, the parental use of wh-questions, a strategy promoted in the PLAY intervention for parents of children with a high language level, was analyzed. In the PLAY project, parents were encouraged to use wh-questions that follow the typical acquisition progression (i.e., first "what," then "where," then "who," etc.). In typically developing children, wh-questions play a strong role in developing vocabulary and improving grammatical complexity of expressive language (Blewitt, Rump, Shealy, & Cook, 2009; Senechal, 1997; Valian & Casey, 2003). However, in this study, high parental wh-input was not associated with high concurrent child language measures in the whole population at baseline, and child language measures did not significantly increase as parents asked a greater proportion of wh-questions from pre-to post-intervention.

There are many possibilities as to why wh-questions were not associated with higher language sample scores in children with ASD. It is possible that no significant relationships

between child language measures and wh-questions were found because wh-questions require a level of critical thinking that was not yet present in the individuals with ASD enrolled in the original study. Another possibility is that children with ASD are not able to interpret and appropriately answer wh-questions in the way that typically developing children are able to. There is also a wide variety of forms of wh-questions, which may explain why no strong correlations were seen between wh-question input and child language abilities. Though parents in the PLAY project were instructed to present wh-questions in a developmental order, it is difficult to determine if parents presented questions in this sequence over the time period of the intervention. "What" questions (e.g. "*What is it*?") differ from why questions ("*Why is the girl using an umbrella*?") in their complexity and required critical thinking. These differences make it challenging to determine what types of parental wh-questions may or may not have improved aspects of child language development. Wh-questions can also be closed-ended and have a specific answer ("*Who is it*?"- "*Mama*") or be open-ended and have multiple possible answers ("*What should we do next?*"). As these varying linguistic forms require different types of answers, it is possible that different forms may be associated with different child language output. Further research should be conducted to determine if open-ended versus closed-ended wh-questions have differing impacts on child language development. Wh-questions may serve an alternative function in improving critical reasoning and abstract thinking in children, which are often deficits of ASD, but this study only looked at child language measures. Though this study did not find an association between this form of parental language and high child language output, it is possible that associations between wh-question input and critical thinking skills could be seen in future studies, revealing an alternative function of wh-questions.

Across parental input behaviors, significant changes in child vocabulary and grammatical complexity of spoken language were seen in in the measures of child Types and MLU from pre-intervention to post-intervention. These two measures are the most observable for children with lower language profiles, thus, it seems many instructed changes in parental question input coached by the PLAY project have the strongest impacts on language used by low language children.

In regard to the relationship between questions and turn taking, there were no significant relationships between social turn taking and proportion of parental questions at baseline or from pre-to post-intervention. Questions typically require a response and facilitate a two-way interaction. However, no significant correlation was found between increases in parental question input and greater child turn taking, possibly because children with ASD are not as receptive as typically developing children to the cues of intonation, parental expectancy, and social exchanges.

Treatment Implications

The PLAY project attempts to teach parents a wide variety of strategies and techniques to use during play interactions with the goal of improving the communicative abilities of children with ASD. This study assessed how effectively the PLAY project implemented question asking strategies in parents and if these strategies appeared beneficial for child language growth.

The PLAY project promotes the concept of using concrete, salient language instead of questions to open communication circles with children with ASD. Parents who underwent PLAY intervention decreased their proportion of question input from pre- to post- intervention. However, maintaining a high proportion of parental question input was positively associated with measures of child vocabulary and grammatical complexity of expressive language,

particularly for children in the low language group. While not taught in the PLAY project, increased parental question use appears to correlate with higher child language measures, suggesting further adjustment of strategies presented in the PLAY project may be required to produce language gains in all participants.

Parents who underwent PLAY intervention training did not significantly change their proportion of Asked and Answered input from pre-to post- intervention observation sessions, although this was a strategy promoted in the intervention. However, when tracked, for parents who did increase their use of Asked and Answered from pre-to post-intervention, child vocabulary and grammatical complexity of spoken language significantly decreased from pre- to post-intervention recording sessions, even though a year in time had lapsed. Thus, this strategy was not associated with improved language sample measure scores between the two sampling sessions. Moreover, the PLAY project training did not appear to successfully teach parents to use this strategy, if the taped interactions mirrored daily input models. Thus, the strategy of emphasizing Asked and Answered questions in parent trainings such as the PLAY project requires further analysis, as the strategy, when targeted for specific analysis, does not appear to promote language growth for children with the profiles studied here, and parents did not frequently seem to utilize the strategy in the post-treatment sessions, for reasons that are not known.

The PLAY project encourages parents to ask wh-questions as children move to higher developmental levels to improve critical thinking and advanced language use. No significant change in wh-question input was present in parents in the PLAY intervention, when compared to parents in the contrast group. However, there were no significant relationships between paternal wh-question use and measures of child vocabulary development, grammatical complexity of

spoken language, or turn taking. Wh-question input may not be as effective for eliciting change in language use in children with ASD as it appears to be with typically developing children. As there are multiple types of wh-questions, further research is needed to establish which forms of wh-questions, if any, are associated with growth in child language abilities in children with ASD.

As neither Asked and Answered nor the use of wh-questions showed marked changes in the speech of mothers implementing the PLAY project, some reconsideration of parental advisement may be in order. This is an intervention that contains a large number of strategies and components, which may make it difficult for parents to incorporate all strategies equally well (or demonstrate them in a single 15-minute play session). In the original study, parents were trained through written instructions and mentoring by coaches. It is possible that post-hoc analysis of the PLAY and other parent-child interactions in the ASD population may shed light on which particular strategies appear to induce the most positive change in child language and child behavior. Limiting the number of strategies presented, particularly since some were not linked to changes in language development, may allow for better implementation of key strategies by parents.

Table 14: Summary of PLAY group analysis results

	Encouraged in PLAY Project?	**Change in Parent Input**	**Associations with Child Language Abilities**
General Question Input	No	Decrease	Positive
Asked and Answered Questions	Yes	No significant change	Negative
Wh-questions	Yes	No significant change	No effect

Implications for the ASD Population

The second analysis conducted in this study assessed the relationship between parental question input and concurrent child language abilities at baseline using both the PLAY group and the comparison group, allowing general trends between parental language input and child language abilities in the ASD population to be seen. Children with ASD seem to benefit from high question input in earlier stages of language development, possibly due to greater exposure to varying grammatical structures and vocabulary, or the fact that questions elicit some response from the child. High question inputis associated with fewer language gains as children's language advances. With or without intervention training, high Asked and Answered input was correlated with low child language measures as baseline, revealing that this strategy may be less effective in eliciting advanced language for children with ASD as compared to reports published using typically developing children. Although wh-question input is beneficial for language development in typically developing children, high wh-question input was not associated with more diverse vocabulary, grammatical complexity, or turn taking in the parent-child play language samples of children with ASD. Children with ASD may interpret and utilize question input in different ways than their typically developing peers, or respond differently to such conversational gambits, which presents the need for greater research into how children with ASD interpret and respond to questions.

Limitations

This study had limitations in that only child expressive language measures were assessed. It is possible that question input, particularly Asked and Answered, may have a positive impact on receptive language. This study was also limited in how wh-questions were assessed. All wh-questions were assessed as one group, instead of divided by open-ended or closed-ended, or by

which wh-word was utilized. Future research should work to gain a greater understanding of how children with ASD interpret different types of wh-questions. Further research is needed to establish how children with ASD interpret questions and what types of questions are effective for improving child language development.

While valuable, single baseline and outcome recordings of parent-child interactions, especially short interactions, are unlikely to inform the mechanisms of action that moderate outcomes in complex parent training programs such as the PLAY project. At the very least, mid-point samples, and a variety of contexts may help us understand how parents adopt PLAY interaction strategies, and how these relate to child outcomes.

Additionally, pulling apart small components of the intervention, and asking how they accomplish the myriad of verbal and non-verbal goals of the program may be asking how much a single ingredient in complex parent-child interactions impacts the trajectory of child language growth, let alone other aspects of interaction and development. However, when additional specific aspects of the program are evaluated, a set of more and less influential components may be identified. The study assessed only question input and did not determine which other components of the PLAY project parent training may have been related to higher child language profiles.

Chapter 5: Conclusion

The current study further studied outcomes of the parent implemented PLAY intervention RCT by assessing how parental language input affects child language output. The PLAY project has been found to improve parent-child interactions and decrease autism-related diagnostic symptoms (Solomon, Van Egeren, Mahoney, Huber, & Zimmerman, 2014). The PLAY project improved child language outcomes when natural language sample analysis was utilized in a pilot analysis (Catalano, Ratner, & Solomon, 2016). Further analysis revealed that language gains seen in children enrolled in the PLAY project were comparable to gains in children who underwent treatment-as-usual (Dominguez, Garbarino, Ratner, & Solomon, 2018), showing that the PLAY intervention is as effective in changing child language profiles as other treatment approaches to ASD.

Surprisingly, parental question input significantly decreased in parents enrolled in the PLAY project, though this decrease was not significant when compared to parents in the comparison group. However, analysis on the effect of question input reveals that increased overall question input does elicit higher child language performance on the measures we utilized. A high proportion of parental question input was associated with high concurrent scores for child vocabulary and grammatical complexity of spoken language at baseline, particularly in children with lower language profiles. In the PLAY project, positive change in the proportion of questions asked by parents was associated with positive changes in child vocabulary from pre-to post-intervention. No associations were found between rate of parental question input and child turn taking.

Use of specific question types that were Asked and Answered appeared to negatively relate to child language scores on outcome measures, as seen in the post-treatment recordings. In

children with low language profiles enrolled in the PLAY project, child vocabulary and grammatical complexity of expressive language all decreased from pre-to post-intervention with an increase in parents' Asked and Answered input during those sessions. Although a focused strategy in training parents, it was not implemented by parents at a higher rate from pre-to post-intervention when compared to parents in the uninstructed comparison group.

Parental wh-question input was promoted in the high language PLAY group to improve child language skills and critical thinking. However, high proportions of wh-question input were not associated with high concurrent child language profiles at baseline. Change in parental proportion of wh-questions from pre-to post-intervention was also not associated with gains in child language measures. Parents enrolled in the PLAY project did not significantly change the proportion of wh-questions they used from pre-to post-intervention, as compared to the comparison group. For both of these question types, further research may be needed to see if these findings, derived from single play sessions being recorded by investigators, are representative both of parent language use, and child language growth, as appraised in different settings, as question input may have more diffuse impacts on child language growth than can be appreciated by examining the child's immediate responses to such questions.

Two of the parental question input strategies promoted in the PLAY project did not appear to be associated with gains in child language profiles and were not more frequently observed in the post-intervention language of parents enrolled in the program. As the PLAY project did appear to improve language sample analysis outcomes in the same sessions, it would be beneficial to establish which parental strategies were effective for language development in children with ASD. This will allow the PLAY project to implement the most effective parent input strategies to create the greatest possible child language gains for children with ASD.

Appendix

List of Participants Used from Original RCT and their Baseline Language Measures

ID Number	MLU	Types	VOCD	IPSyn
100243	1.625	10	N/A	N/A
100443	1	4	N/A	N/A
100543	1	1	N/A	N/A
100673	2.588	24	N/A	N/A
100743	3.009	98	35.8	64
100873	1.595	71	28.34	21
101143	2.667	81	18.16	51
101273	2.733	91	31.84	54
101373	2.468	134	70.42	52
101443	2.157	43	18.05	N/A
101673	3.689	158	59.58	77
101873	1.091	6	N/A	N/A
101943	1	1	N/A	N/A
102043	2.316	69	35.33	N/A
102173	1.286	14	N/A	N/A
102273	2.571	24	6.48	N/A
102543	1.577	21	N/A	N/A
102673	2	1	N/A	N/A
102743	1.714	5	N/A	N/A
120243	1.716	86	24.97	45
120473	1.157	30	17.78	N/A
120573	2.126	84	36.12	45
120673	2.909	12	N/A	N/A
120773	2.375	33	15.6	N/A
120843	2.164	65	22.73	37
120943	2.293	48	30.88	N/A
121073	1.802	66	28.2	34
121273	2.081	57	30.57	N/A
121573	1	7	N/A	N/A
121643	1.75	20	N/A	N/A
121743	2.049	37	10.94	N/A
121843	1.938	22	N/A	N/A
121973	1.143	5	N/A	N/A

122073	3.276	116	36.42	68
122143	1	3	N/A	N/A
122543	1.467	29	N/A	N/A
122643	1.117	49	28.66	11
122773	4.091	97	31.76	64
123043	1.817	83	35.14	41
123143	2.772	93	26.7	65
200143	3.625	49	30.89	N/A
200373	3.221	84	44.03	59
200443	2.032	75	39.53	34
200573	2.793	91	29.34	57
200673	2.04	71	35.14	41
200773	2	16	N/A	N/A
200843	1	7	N/A	N/A
201043	2.759	173	47.4	49
201273	2.89	107	40.6	59
201373	1.4	54	38.83	26
201473	3.319	115	32.99	61
201573	1	6	N/A	N/A
201743	3.782	78	25.2	N/A
201943	1.625	5	N/A	N/A
220173	1.87	28	N/A	N/A
220573	1	3	N/A	N/A
220673	1.789	85	52.82	41
220743	1.194	29	N/A	N/A
221173	1	2	N/A	N/A
222343	3.689	120	36.33	64
222443	0	0	N/A	N/A
230443	1.842	17	N/A	N/A
230543	1	1	N/A	N/A
230673	2	37	35.4	N/A
230773	1.977	60	46.13	N/A
231043	2.892	93	43.37	59
231243	2.797	75	28.88	63
240873	2.755	135	50.69	64
241143	1.808	81	48.45	46
241943	1.119	28	7.49	N/A
300143	5.94	187	47.71	80
300243	2	8	N/A	N/A

300473	1	1	N/A	N/A
300573	3.788	110	31.06	65
300643	0	0	N/A	N/A
400143	2.874	98	54.53	58
400373	1.4	7	N/A	N/A
401043	1.723	31	7.95	N/A
401143	1	3	N/A	N/A
401243	2.294	29	15.49	N/A

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